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भारतीय मानक

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Indian Standard

REQUIREMENTS AND METHODS FOR AGEING TEST, SELF-HEALING TEST AND DESTRUCTION TEST ON SHUNT CAPACITORS OF THE SELF-HEALING TYPES FOR AC POWER SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 650 V

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NEW DELHI 110002

November 1992 **Price Group 2**

Power Capacitors Sectional Committee, ET 29

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Capacitors Sectional Committee had been approved by the Electrotechnical Division Council.

While revising IS 2834 : 1986 'Shunt-capacitors for power systems (*second revision*)', it was found necessary to follow International practice of specifying the requirements of LV/MV and HV capacitor separately. Further, the requirements applicable to self-healing type shunt capacitors have been given separately in IS 13340 : 1992 'Shunt capacitors for the self-healing type for ac power systems having a rated voltage up to and including 650 V'. This standard supplements the requirements and methods of test applicable to capacitors covered in IS 13340 : 1992.

This standard is adopted from IEC Report 831-2 (1988) 'Requirements for ageing test, self-healing test, and destruction test of shunt capacitors of the self-healing type for ac power systems having a rated voltage up to and including 660 V', issued by the International Electrotechnical Commission (IEC).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 1 JUNE 2002
TO
IS 13341 : 1992 REQUIREMENTS AND METHODS FOR AGEING TEST, SELF-HEALING TEST AND DESTRUCTION TEST ON SHUNT CAPACITORS OF THE SELF-HEALING TYPE FOR AC POWER SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 650 V

(*First cover page and page* 1, *title*) — Substitute '**1 000 V**' *for* '**650 V**'

(*Page* 1, *clause* **1**, *line* 4) — Substitute '1 000 V' *for* '650 V'

(ET 29)

Reprography Unit, BIS New Delhi India

Indian Standard

REQUIREMENTS AND METHODS FOR AGEING TEST, SELF-HEALING TEST AND DESTRUCTION TEST ON SHUNT CAPACITORS OF THE SELF-HEALING TYPES FOR AC POWER SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 650 V

1 SCOPE

This standard specifies the requirements for a ageing test, self-healing test and destruction test applied to self-healing type shunt capacitors rated up to 650 V ac

2 REFERENCES

The Indian Standards listed below have either been referred or form necessary adjuncts to this standard

IS No.	*Title*
1885 (Part 42) : 1985	Electrotechnical vocabulary: Part 42 Power capacitors
IS 13585 : 1992	Shunt capacitors of non-self-healing type for ac power systems having rated voltage up to and including 650 V
13340 : 1992	Shunt capacitor of self-healing type for ac power systems having rated voltage up to and including 650 V

3 TERMINOLOGY

The definitions of terms given in IS 1885 (Part 42) : 1985 and IS 13340 : 1992 shall be applicable

4 REQUIREMENTS OF SHUNT CAPACITORS

4.1 Shunt Capacitors of Non-Self-Healing Type

The requirements specified in IS 13585 : 1992 shall be applicable.

4.2 Shunt Capacitors of Self-Healing Type

The requirements given in **5** to **7** shall be applicable in addition to those given in IS 13340 : 1992.

5 AGEING TEST

5.1 Conditioning

The temperature of the case during the ageing test shall be the highest mean temperature in 24 h (*see* Table 1 of IS 13340 : 1992) plus the difference between the measured temperature of the case and the cooling air temperature recorded at the end of the thermal stability test (*see* IS 13340 : 1992) carried out on an identical unit

The test methods given in **5.2** and **5.3** are intended to ensure that the capacitor case temperature is maintained constant during the test. The two methods are considered as being equivalent. The units that are not sealed shall be tested in air, with forced circulation

5.2 Testing in Air with Forced Circulation

5.2.1 The capacitor unit is mounted in an enclosure in which heated air is circulated with an air velocity such that temperature variations at any point of the enclosure shall not exceed ± 2°C. The sensitive element of the thermostat regulating the temperature in the capacitor enclosure should be located on the surface of the capacitor container, three-quarters of the way up

5.2.1.1 The capacitor shall be placed in a vertical position with the terminals upright

5.2.1.2 When many capacitors are tested together, they shall be placed with sufficient clearance between them in order to have sufficient temperature uniformity

5.2.1.3 After placing the capacitor in the unheated enclosure, the thermostat shall be set at a temperature equal to that given in **5.1**. Then, without energizing the capacitor, the enclosure shall be brought to thermal stability, which shall be deemed to have been reached when the container temperature of the capacitor has reached the stated temperature within a tolerance of ± 2°C.

5.2.1.4 The capacitor shall then be energized at the voltage stated in **5.4.1** (a)

5.3 Testing in a Liquid Bath

5.3.1 The capacitor unit is immersed in a container filled with a liquid which, by appropriate heating, is kept at the temperature given in **5.1** during the whole test. This temperature is maintained with a permissible change of ± 2°C Care must be taken to ensure that the temperature in the neighbourhood of the capacitor is within these limits.

5.3.1.1 The capacitor is not energized until it has reached the temperature of the oil bath

5.3.1.2 The capacitor shall then be energized at the voltage specified in **5.4.1** (a)

NOTE — Where the terminal insulation, or the insulation of cables permanently attached to the capacitor, is of material that might be damaged by the heating liquid, it is permissible for the capacitor to be positioned in such a manner that these terminals or cables are just above the surface of the liquid

5.4 Test Sequence

5.4.1 Before the test, the capacitance shall be measured as prescribed in **5.1** The test sequence is in three parts as follows·

a) the capacitor shall be energized at a voltage equal to 1 25 U_N for 750 h;

b) the capacitor shall then be subjected to 1 000 discharge cycles consisting of

   i) charging the capacitor to a dc voltage of 2 U_N, and

   ii) discharging the capacitor through an inductance of.

$$L = \frac{1\,000}{C}\ \mu H$$

   Tolerance ± 20 percent in which C is the measured capacitance in μF

   The cables used for the external circuit and the inductance shall have a cross-section appropriate to the *maximum* permissible current (*see* **6.2** IS 13340 : 1992) The duration of each cycle shall be 30 s minimum

c) repetition of part (a) above

5.4.1.1 During the whole test sequence the temperature of the case shall be maintained equal to that given in **5.1**

5.4.2 In the case of three-phase capacitors, the first and the third parts of the test sequence [*see* **5.4.1** (a) and (c)] should be carried out with all the phases energized at 1 25 U_N. This could be obtained either by using a three-phase source, or by using a monophase source and modifying the internal capacitor connections

The second part [*see* **5.4.1** (b)] of the test sequence, however, should be carried out on two phases only In the case of a star connection, modification of the internal connections would be necessary, or the charging voltage should be increased from 2 U_N to 2 31 U_N.

5.5 Test Requirements

5.5.1 During the test no permanent breakdown, interruption or flashover shall occur. At the end of the test the capacitor shall be allowed to cool down freely to the ambient temperature and the capacitance shall then be measured under the same conditions as before the test. The maximum permitted variation of capacitance compared to the values measured before the test shall be 3 percent averaged over all the phases and 5 percent on one phase For single phase capacitors, variation of 5 percent may be permitted

5.5.2 The ac voltage test between terminals and container shall be carried out with the same procedures as prescribed in **17.2** of IS 13340 : 1992

5.5.3 The sealing test shall be repeated as prescribed in **19** of IS 13340 1992

6 SELF-HEALING TEST

6.1 This test may be carried out on a complete unit, or on a separate element or on a group of elements that are a part of the unit, provided the element or the elements under test are identical to those used in the unit and their conditions are similar to those they have in the unit The choice is left to the manufacturer.

6.2 AC voltage across the capacitor or element shall be gradually increased up to 1.75 U_N and maintained for 10 seconds

6.2.1 If fewer than five breakdowns occur during 10 s time, the voltage shall be increased slowly until five breakdowns have occurred since the begining of the test or until the voltage has reached 3 5 times the rated voltage.

6.2.2 If fewer than five breakdowns have occurred when the voltage has reached 3 5 U_N the test may be continued until five breakdowns are obtained or may be interrupted and repeated on another identical unit or element, at the choice of the manufacturer.

6.3 Before and after the test, the capacitance shall be measured and the change in value shall not exceed 2 percent

NOTES

1 Breakdown during the test may be detected by an oscilloscope or by an acoustic or a high-frequency test method

2 The test carried out on a part of a unit can facilitate the detection of self-healing breakdown.

3 For polyphase capacitors, the test voltages shall be adjusted accordingly

4 When comparing the results of capacitance measurement obtained before and after the test, two factors shall be taken into acconnt:

a) the reproducibility of the measurement;

b) the fact that an internal change in the dielectric may cause a small change in the capacitance without detriment to the capacitor.

7 DESTRUCTION TEST

7.1 The principle of the test is to promote failures in the elements by dc voltage and subsequently to check the behaviour of the capacitor when an ac voltage is applied.

7.1.1 The test shall be carried out on a capacitor unit, if necessary the discharged resistors shall be disconnected in order to avoid burning

7.1.2 A capacitor which has passed the ageing test may be used

7.2 For polyphase units the test shall be carried out between two terminals only In the case of three-phase delta connection two terminals shall be short-circuited For star connection no terminals shall be short-circuited.

7.3 The capacitor shall be mounted in a circulating air oven having a temperature equal to the maximum ambient air temperature of the temperature category of the capacitor.

7.4 When all the parts of the capacitor have reached the temperature of the oven the test sequence given below shall be performed with the circuit shown in Fig 1.

a) While keeping the selector switches *H* and *K* in positions 1 and *a* respectively, the ac voltage source is set to 1.3 U_N and the capacitor current is recorded,

b) The dc source is set to 10 U_N, the switch *H* is then set to position 2 and the variable resistor *R* is adjusted to give a dc short-circuit current of 300 mA,

c) Switch *H* is set to position 3 and switch *K* to position *b* to apply the dc test voltage to the capacitor which is maintained until the voltmeter indicates approximately zero for 3 to 5 s, and

d) Switch *K* is then set to position *a* again to apply the ac test voltage to the capacitor for a period of 3 min when the current is again noted

7.4.1 The following conditions may be obtained and checked:

i) The ac ammeter *I* and the voltmeter *U* both indicate zero	In this case the fuse shall be checked If it has blown it shall be replaced Then the ac voltage is applied to the capacitor and if the fuse blows again the procedure is interrupted If the fuse does not blow the procedure of application to the capacitor of dc and ac voltage as prescribed in **7.4** (c) and (d) continues using only the switch *K*
ii) The current indicated by the ac ammeter *I* is lower than 66 percent of the initial value and the voltmeter *U* indicates 1.3 U_N	In this case the procedure is interrupted
iii) The current indicated by the ammeter *I* is higher than 66 percent of the initial value.	The procedure (dc – ac) continues

7.4.2 When the procedure is interrupted the capacitor is cooled to the ambient temperature and the voltage test between terminals and the container is carried out according to **16.1** of IS 13340 : 1992 applying an ac voltage of 1 500 V

7.5 Measurement Circuit (*see* Fig. 1)

7.5.1 The minimum short circuit current of the ac generator is 2 000 A at the capacitor terminals.

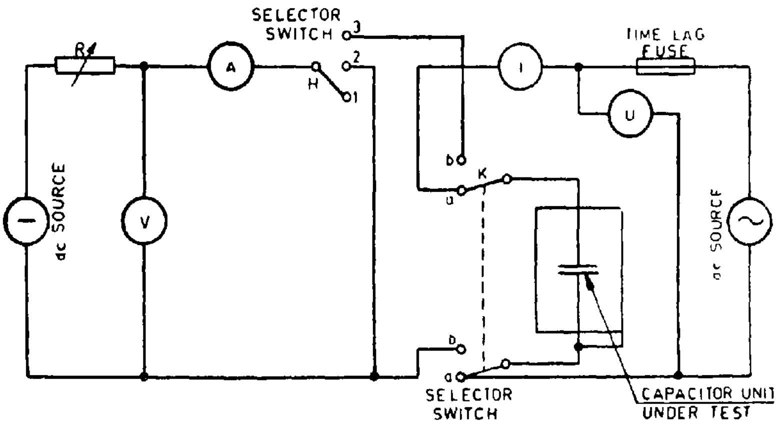

FIG. 1 CIRCUIT TO PERFORM DESTRUCTION TEST

7.5.2 A time-lag fuse for domestic and similar purposes shall be used. The rated current I_F of the fuse shall be obtained by the formula:

$$I_F = k \cdot I \qquad (\text{Amps})$$

where

$$k = \frac{100}{Q}$$

$Q = Q_N$ in Kvar, in the case of a single-phase capacitor,

$Q = 2/3\ Q_N$, in the case of a three-phase delta — connected capacitor with two terminals connected together or three-phase star capacitor with two terminals connected only,

$I = I_N$ in A, in the case of a single-phase or star — connected three-phase capacitor,

$I = 2/\sqrt{3}\ (= 1.155)\ I_N$ in A, in the case of a three-phase delta — connected capacitor with 2 terminals connected together, and

$I = 1/\sqrt{3}\ (= 0.577)\ I_N$ in A, in the case of a star-connected three-phase capacitor with two terminals connected only.

NOTE — For three-phase star capacitor connected with two terminals only, the voltage will be adjusted accordingly. This for the testing voltage leads to increase the value of 1.3 U_N ac by a factor $2/\sqrt{3}$ means 1.5 U_N.

7.5.3 *Test Requirements*

7.5.3.1 At the conclusion of the test the enclosure of each capacitor shall be intact except that normal operation of a vent, or minor damage of a case (for example cracks) is permitted provided the following conditions are met:

a) Escaping liquid material may wet the outer surface of the capacitor but shall not fall in drops,

b) The container of the capacitor may be deformed and damaged but not broken,

c) Flames and/or fiery particles shall not be emitted from the openings. This may be checked by enclosing the capacitor in gauze (cheese cloth). Burning or scorching of the gauze is then considered to be a criterion of failure,

d) The result of an ac voltage test between terminals and container with 1 500 V for 10 s shall be satisfactory.

NOTE — Excessive emanation of fumes during the test could be dangerous and thus precautions should be taken.

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